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Detecting the Transverse Proximity Effect: Radiative Feedback from QSOs

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Abstract. We present results of a search for absorbers close to QSOs near the line of sight of background quasars based on sensitive Keck/HIRES observations of the QSO triplet KP76, KP77, and KP78 (z=2.466, 2.535, and 2.615), with separations of 2-3 arcmin on the plane plane of the sky. Through the use of a high resolution spectra, together with accurate systemic redshifts of the QSOs using near-IR spectroscopy, we quantify the state of the IGM gas at the redshifts of the foreground QSOs. The inferred ionizing flux at the proper transverse distances probed is up to 100 times greater than the UV background. We show that the state of the gas has been significantly affected by the UV radiation from the foreground QSOs.

1. Introduction

The proximity effect is characterized by a lack of hydrogen absorption lines close to a quasar and results from the intense ionizing radiation flux produced by it (e.g. Scott et al. 2000). On the other hand, the transverse proximity effect is the expected influence of a foreground object on gas along the line of sight of a background object. Previous work has actually found an increase in number of absorption lines at the redshift of the foreground object (Crotts & Fang 1998; Croft 2004; Schirber et al. 2004; Hennawi et al. 2006). Proposed explanations for these results include time variability of the quasar radiation, or an increase in number density of absorbers, since the QSOs inhabit overdense environments. In this work, we investigate the effect of QSOs on their environment through analysis of absorption lines in a quasar triplet (KP76, KP77 and KP78), within the Q1623 field. We used the high-resolution spectrograph (HIRES) on Keck I to observe the three quasars in the triplet. Precise near-infrared spectroscopy of the quasar triplet and subsequent accurate redshift measurements allowed us to search for absorbers in a range of approximately ± 1000 km s^{-1} around each foreground object. We compare predictions from an ionization code (Ferland et al. 1998) to values determined through fitting Voigt profiles to the observed spectra (Carswell et al. 2001).

2. Results and Discussion

The joint constraints on the column density ratios imply that the ionization parameter (U) in some of these clouds is close to 1 (Figure 1.a). If one were to assume that the QSOs make negligible contributions to the radiation field, the implied hydrogen number density would be $\sim 10^{-5}$ cm^{-3}, which would in

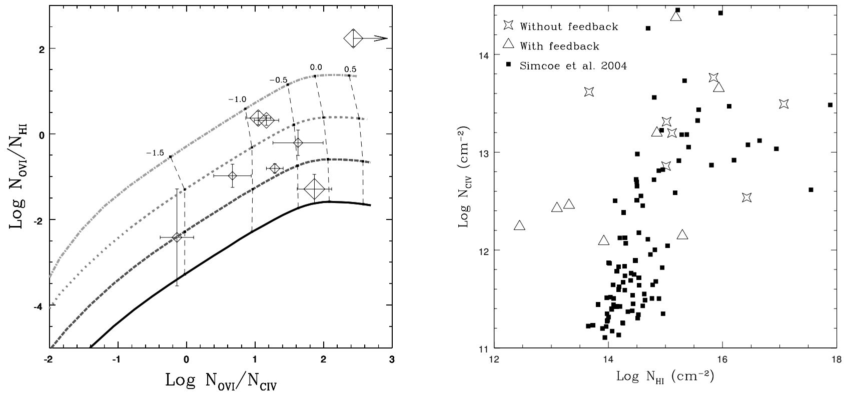

Figure 1. *Left*: Comparison between column density ratios as predicted by Cloudy for different metallicity values (represented here by different line types) versus Voigt profile fitting of the observed quasar spectra. Dashed lines indicate distinct ionization parameters and symbol size indicates nominal radiation flux from the foreground QSO. As expected, there is a correlation between both measurements. *Right*: Comparison between measured column densities (triangles), inferred column densities without radiative feedback from the foreground QSO (crosses) and values from Simcoe et al. (2004). With the QSO turned off, column densities seem to correlate well with previous works.

turn require an object of several tens of Mpc in size to achieve measured column density values. We conclude that radiation from the foreground QSO must be present. Moreover, clouds farther away from the foreground QSOs present lower ionization parameters, as one would expect. Most systems lie in the region between a thousandth and a tenth solar metallicity.

Figure 1.b shows the results of computing column densities assuming no radiative feedback from the QSOs. Compared to a sample of absorbers along the line of sight of different quasars (Simcoe et al. 2004), we notice the values are similar, unlike our original measurements, represented by triangles. This reinforces the idea that our sample is distinct because of the ionizing radiation from the nearby quasars. For more details on this work, we refer the reader to Gonçalves & Steidel (2007), in preparation.

References

Carswell, R. F. et al. 2001, VPFIT Manual,
http://www.ast.cam.ac.uk/∼rfc/vpfit.html
Croft, R. A. C. 2004, ApJ, 610, 642
Crotts, A. P. S., & Fang, Y. 1998, ApJ, 502, 16.
Ferland, G. J. et al. 1998, PASP, 110, 761
Hennawi, J. F. et al. 2006, ApJ, 651, 61
Schirber, M. et al. 2004, ApJ, 610, 105
Scott, J. et al. 2000, ApJS, 130, 67
Simcoe, R. A. et al. 2004, ApJ, 606, 92